Summary of "Immunization Rates and Hospitalization for Community-Acquired Pneumonia in Alberta"

By Y. Jin, K.C. Carrière, G. Predy, D. Johnson, T.J. Marrie

Purpose

This study compared rates of influenza vaccination in Alberta health regions to the rates and cost for community-acquired pneumonia.

Approach

Four administrative health service databases were used for health services provided during the period April 1, 1999 to March 31, 2001.

Key findings

The following are the key findings of this study:

- The influenza vaccination rate for Alberta seniors varied between thirty to eighty percent in the seventeen health regions.
- A mean Alberta vaccination rate of about seventy percent compares favorably to other published vaccination rates.
- The vaccination rate varied with residence location: highest in the two metropolitan regions of Calgary and Edmonton, lower in non-metropolitan / rural regions, and lowest in more remote northern regions.
- The annual hospitalization rate for community-acquired pneumonia in Alberta seniors was two percent.
- The annual rate of a physician diagnosis of ambulatory community-acquired pneumonia in Alberta seniors was 6.5 percent.
- The per capita vaccination cost (about $10) was small in relation to the per capita cost of hospital care for pneumonia (about $100).
- Lower vaccination rates were associated with higher ambulatory pneumonia rates, higher rates of pneumonia requiring hospitalization, and higher total per capita physician and hospital costs for pneumonia.
- The association of higher per capita costs and rates for community-acquired pneumonia with lower vaccination rates was especially strong in the northern, remote health regions.

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Conclusions

This study illustrates the variations in outcomes within Alberta as different health authorities utilize or under-utilize an effective preventive therapy. Regional under-utilization of preventative influenza vaccination in Alberta seniors is associated with increased utilization of health services for pneumonia.

For more information

Copies of the report are available from the

Alberta Centre for Health Services Utilization Research

- by contacting David Johnson by e-mail at cujecjohnson@shaw.ca
- at http://www.health.gov.ab.ca/system/key/Research/achsur_reports.html

Alberta Centre for Health Services Utilization Research

The Alberta Centre for Health Services Utilization Research is a joint initiative between the University of Alberta and the University of Calgary, funded by Alberta Health and Wellness. The Centre conducts studies of how health services are used and delivered to inform health policy development and management of health services delivery.

Release date

August, 2003

IMMUNIZATION RATES AND HOSPITALIZATION FOR COMMUNITY-ACQUIRED PNEUMONIA IN ALBERTA

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      iv. Methods ☐
      v. Findings ☐
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      vii. Recommendations ☐

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3. The findings were presented clearly.

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4. The tables and figures helped me to understand the findings.

   Yes ☐ No ☐

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Immunization Rates and Hospitalization for Community-Acquired Pneumonia in Alberta

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SUMMARY

The Canadian National Advisory Committee on Immunization recommends a yearly influenza vaccination for all those sixty-five years and older. We compared regional rates of influenza vaccination to the rates, cost, and mortality for community-acquired pneumonia using Alberta hospital administrative data during the period April 1, 1999 to March 31, 2001. We found the influenza vaccination rate for the seventeen health regions varied between thirty and eighty percent (mean seventy percent) in Alberta seniors (n = 298,473). The annual hospitalization and ambulatory community-acquired pneumonia attack rates were two percent and 6.5 percent per year respectively. There were statistically significant correlations between lower influenza vaccination rates and higher community diagnosed pneumonia rate, higher pneumonia rate requiring hospitalization, higher total per capita physician, and hospital costs for pneumonia and per capita in-hospital mortality for pneumonia . Per capita costs, rates, and mortality were highest and influenza vaccinations rate lowest in the northern, remote health regions. The per capita vaccination cost (about $10) was small in relationship to the per capita cost of hospital care for pneumonia (about $100). We conclude that regional under-utilization of preventative influenza vaccination in Alberta seniors is associated with increased utilization of health services for community-acquired pneumonia.

INTRODUCTION

The Canadian National Advisory Committee on Immunization recommends a yearly influenza vaccination for those sixty-five years and older [1]. The Canadian National Advisory Committee on Immunization recommends a vaccination rate of ninety percent for all those sixty-five years and older. Evidence from cohort studies and randomized trials demonstrate that influenza vaccination prevents pneumonia by fifty-three percent, hospitalization for pneumonia by forty-eight percent, and mortality in those with pneumonia by sixty-eight percent [2-4]. These benefits in the United States and Britain were found in population studies with a vaccination rate of forty percent [3] to fifty-two percent [5]. In high-risk patients (seniors with chronic lung disease, long term care residents) vaccination rates were sixty to seventy percent [4, 6, 7]. In this study, we use administrative data and associate the regional rates of influenza vaccination coverage to the rates, cost, and mortality for community-acquired pneumonia in Alberta during the period April 1, 1999 to March 31, 2001.

METHODS

Four administrative health service databases were used and the analysis was done within the protected environment of Alberta Health and Wellness, which is governed by provincial legislative guidelines on the confidentiality of health information.

1. Canadian Institute for Health Information's (CIHI) Inpatient Discharge Abstract Database (DAD) for the province of Alberta for 1999/2000 to 2000/2001,
2. Alberta Physician Claims Assessment System Database for 1999/2000 to 2000/2001,
3. Alberta Health Insurance Plan Registry File for 1999/2000 to 2000/2001, and
4. Alberta vaccination registry 1999/2000 to 2000/2001.

Inclusion Criteria:

Hospital diagnosed community-acquired pneumonia was defined as the diagnosis deemed the most responsible for the hospital admission or any of the other fifteen diagnosis codes defined to be Type 1 (pre-admit comorbidity). These diagnosis were coded by ICD-9-CM values of 480.x to 487.x (pneumonia) or 507.x (aspiration pneumonia) excluding 484.x (pneumonia of infectious diseases classified elsewhere) [8, 9] found in the Canadian Institute for Health Information's (CIHI) Inpatient Discharge Abstract Database (DAD) for 1999/2000 and 2000/2001.

Exclusion criteria:

1. Not an Alberta resident or not treated in an Alberta acute care facility,
2. Adjacent diagnosis related group (ADRG) defining hospitalization for a surgical procedure, and
3. Any previous hospitalization within ten days of incident pneumonia case.

Ambulatory diagnosed community-acquired pneumonia was defined using the Alberta Physician Claims Assessment System Database. All physician consultation claims (CPX 03.x) [10] with the most responsible diagnosis of community-acquired pneumonia (as defined above) were extracted. In-hospital claims and claims within ten days before or after a hospital diagnosed community-acquired pneumonia were linked using anonymous personal identifier and excluded as ambulatory diagnosed community-acquired pneumonia. The maximum yearly incidence of community-acquired pneumonia per senior was limited to a maximum of seven distinct episodes of pneumonia by excluding all subsequent claims within sixty days of first claim found within the two year study.

All pneumonia rates are age-specific using the population of seniors. All hospitals in Alberta are administered by an autonomous regional board in each of the seventeen health regions. Nearly all three million residents of Alberta are enrolled in the public health care insurance plan and reside in one of the seventeen health regions. Each region is responsible for influenza vaccination program delivered by physicians in the community and public health nurses. The composition of the vaccines used in each year reflected the actual strains that circulated in the province. The costs of the vaccination and delivery program were obtained from the Capital Health Authority. Numbers of vaccinations and demographic characteristics of those vaccinated are anonymously recorded and reported to the provincial government.

Hospital costs per resource group number (RGN) were calculated using the provincially approved methodology as set forth by the Provincial Costing Project and in accordance with the Provincial and National Management Information Systems guidelines [11, 12]. Total costs combine allocation and assignment of all direct and indirect costs associated with an in-patient encounter from the time a patient is admitted to the hospital to the time they are discharged. All costs were estimated in 1998/1999 and assumed similar for all the study years. The quality of the data reporting of costs in Alberta has been highly ranked by the Canadian Institutes for Health Information [13]. As such, the methodological issues that arise around collection of cost data in the United States [14], in part due to the use of prices rather than costs, and for centres in Canada which cost admissions on the basis of "diagnosis related case-mix groupings", do not arise with the majority of the cost data considered in this analysis. Physician costs were calculated from all physician claims for consultation services in seniors with pneumonia (hospital or community diagnosed). Claims were reimbursed expenses in the year of the claim.

STATISTICS

Age-specific rates for vaccination coverage and pneumonia rates were calculated using the average population in the two fiscal years. Lower age limit was sixty-five years at the end of each fiscal year and ninety-five percent confidence intervals were calculated.

As our goal is to establish associations between variables and the scatter plots suggested linear relationships, we adopted the linear correlation measure. We computed the Pearson's correlation coefficients to study the associations between vaccination rate and the four outcomes of community diagnosed pneumonia rate, hospital diagnosed pneumonia rate, total per capita physician and hospital costs for pneumonia, and per capita in hospital mortality for pneumonia. Graphical display further demonstrated their strong associations.

RESULTS

There were 6,038 yearly hospital admissions during the two year study period among 298,473 seniors for community-acquired pneumonia representing an attack rate of two percent. The average cost per hospital admission was $4,651, for a total annual cost of $28 million in Alberta. There were 19,444 episodes of ambulatory community pneumonia diagnosed annually during the two year study period representing an attack rate of 6.5 percent. The average cost for physician consultations per pneumonia episode was $126, for a total annual cost of $2.45 million in Alberta. The number of unique patients with hospital diagnosed pneumonia was 5,217 and unique patients diagnosed with ambulatory community diagnosed pneumonia was 16,229. Table 1 demonstrates the population distribution in each of the seventeen health regions and number of cases of pneumonia treated in hospital and on an ambulatory basis. The in-hospital mortality rate for each hospitalization is also shown.

The average influenza vaccination coverage rate was seventy percent and ranged among regions from a low of twenty-seven percent (95 percent CI 24.8, 29.4) to a high of seventy-seven percent (95 percent CI 76.6, 77.0). The average rate of pneumonia requiring hospitalization was two percent and ranged among regions from a low of 1.6 percent (95 percent CI 1.5,1.6) to a high of 6.4 percent (95 percent CI 5.4, 7.2). The average rate of ambulatory pneumonia was 6.5 percent and ranged among regions from a low of 5.5 percent (95 percent CI 5.1,5.9) to a high of 10.4 percent (95 percent CI 9.3,11.5). The vaccination coverage rate was less than that Alberta average (seventy percent) in thirteen of seventeen health regions. The large population density and high vaccination rate in the two metropolitan regions (Calgary and Capital [Edmonton]) increased the Alberta average to a level greater than that found in most non-metropolitan regions. The rate of ambulatory pneumonia was higher than the Alberta average in eight of the thirteen health regions which had a lower than average vaccination rate. The rate for pneumonia requiring hospitalization was higher than the Alberta average in twelve of the thirteen health regions which had a lower than average vaccination rate. The absolute magnitude of the increased pneumonia rate was greater in the more remote northern health regions.

Table 2 shows the per capita (seniors only) costs and mortality of ambulatory and pneumonia requiring hospitalization in each health region. Per capita physician claims for hospital and community consultations were ten percent of hospital costs. Per capita hospital costs varied over three-fold ($77 to $251) and reflected both the differences in average regional costs ($3,900 to $5,381 per hospitalization) and hospitalization rates (over four-fold variation). The costs of the vaccine, supplies (needles, syringes etc.) and staffing to administer it in one metropolitan region (Capital Health in Edmonton) were $8.23 per dose in 1999/2000 and Can $10.02 per dose in 2000/2001.

Figure 1 shows the vaccination rate, ambulatory pneumonia rate, and rate of pneumonia requiring hospitalization averaged over the two year study period (April 1, 1999 to March 31, 2001). The vaccination rate was less than that Alberta average (seventy percent) in thirteen of seventeen health regions. The large population density and high vaccination rate in the two metropolitan regions (Calgary and Capital [Edmonton]) increased the Alberta average to a level greater than that found in most non-metropolitan regions. The rate of ambulatory pneumonia was higher than the Alberta average in eight of the thirteen health regions which had a lower than average vaccination rate. The rate for pneumonia requiring hospitalization was higher than the Alberta average in twelve of the thirteen health regions which had a lower than average vaccination rate. The absolute magnitude of the increased pneumonia rate was greater in the more remote northern health regions (Peace, Keeweetinok, Northern Lights, Northwestern).

Figures 4 to 7 show the association between vaccination rates and outcomes. All Pearson's correlations were negative; pneumonia rate requiring hospitalization ($r_{1999} = -0.59$ and $r_{2000} = -0.79$ with both $p < 0.05$), total per capita physician and hospital costs for pneumonia ($r_{1999} = -0.57$ and $r_{2000} = -0.79$ with both $p < 0.01$), community diagnosed pneumonia rate ($r_{1999} = -0.39$, $p = 0.12$ and $r_{2000} = -0.70$, $p < 0.01$) and per capita in-hospital mortality for pneumonia ($r_{1999} = -0.30$, $p = 0.24$ and $r_{2000} = -0.57$, $p < .05$). Per capita costs and mortality were higher in the northern, remote health regions. Generally, the trend is downward, indicating that increase in immunization rate is associated with decrease in the outcome considered.

DISCUSSION

The influenza vaccination coverage rate varied between thirty percent to eighty percent in the seventeen health regions for Alberta seniors in the time period April 1, 1999 to March 31, 2001. A vaccination rate of about seventy percent is higher than that found in similar regions [4] and in other studies [3, 5]. The vaccination rate varied with residence location: highest in the two metropolitan regions of Calgary and Edmonton, lower in non-metropolitan / rural regions, and lowest in more remote northern locations. The rates of pneumonia and costs for care followed the same general distribution - proportionally higher in those regions with lower vaccination coverage rates. The effectiveness of vaccination has been previously demonstrated and this study only compliments these previous clinical trials studies [1-7]. This study illustrates the variations in outcomes within one province as different health authorities utilize or under-utilize an effective preventive therapy.

The cost per vaccination of about $10 is small in relationship to the per capita cost of hospital care for pneumonia (about $100). Even if vaccine delivery costs are more expensive in non-metropolitan regions, increasing the vaccination rate to remote communities may still be cost-effective. Despite Alberta's relatively high vaccination rate, the Canadian National Advisory Committee on Immunization target rate of ninety percent of seniors was not achieved, but the provincial government target rate of seventy-five percent was achieved. It was not possible to state net savings comparing vaccinated and non-vaccinated areas, as there was no randomized comparison group in which vaccinations were not given. However, assuming the relationship of hospitalized pneumonia rate and immunization coverage rate was linear, for every increase in vaccination coverage rate of ten percent, the rate of hospitalized community-acquired pneumonia decreased by 0.8 pneumonia cases per one hundred seniors. The additional cost of vaccination (10 times $10 dollars = $100 dollars) would have potentially eliminated the hospitalization of 0.8 pneumonia cases (0.8 times $4,651 cost per case = $3,700) for a potential cost savings of approximately $3,600 dollars per additional one hundred seniors vaccinated. This could also be conceptualized as the cost of influenza vaccination coverage for an additional one hundred seniors in Alberta would need to decrease the 2.0 cases per one hundred seniors rate of pneumonia in Alberta by only eleven percent (i.e. $1,000 cost of vaccination / $9,302 cost of two pneumonia cases per one hundred seniors) which would be less than the reported efficacy in clinical trials.

The statistically significant association between immunization coverage rates and pneumonia rates / costs does not necessarily imply a cause and effect relationship. For example, a lower influenza vaccination coverage rate has been associated with a higher hospitalization rate for pneumonia in Aboriginals [15, 16]. However, remoteness of communities may be the associated factor in explaining both low vaccine rate and higher rate of hospitalizations rather than a direct association between vaccination

coverage and hospitalization rates. The relative higher proportion of Aboriginals in more remote northern regions may have contributed to the high rate of pneumonia in our study. Targeting Aboriginal seniors in remote locations may be a successful strategy in reducing the burden of pneumonia in remote northern regions.

Limitations

Individual data about the use of any influenza and pneumococcal vaccination coverage rates were unavailable. The absence of such information for wider public awareness programs may explain under-utilization of these effective preventative therapies. In this study, only in-hospital mortality for community-acquired pneumonia was analyzed. The cause of an in-hospital death as related to pneumonia had a high degree of certainty [17]. Deaths from community-acquired pneumonia may have also occurred out-of-hospital. Out-of-hospital death data were not available. The absence of this data was unlikely to be large as over seventy-five percent of all deaths in Canada occur while in-hospital [18].

Conclusion

This study illustrates the improved pneumonia outcomes within Alberta as different health authorities increase the utilization of influenza vaccination.

FIGURE LEGEND

Figures 1 to 3 show the rates for immunization and ambulatory/hospital diagnosed pneumonia for each of the seventeen health regions between April 1, 1999 until March 31, 2001. Comparison to the Alberta provincial average (the horizontal line as inserted) can be made by using the ninety-five percent confidence interval.

Figure 4 shows the association between immunization coverage rates and hospital diagnosed pneumonia rate ($r_{1999} = -0.59$ and $r_{2000} = -0.79$ with both $p < 0.05$).

Figure 5 shows the association between immunization coverage rates and community diagnosed pneumonia rate ($r_{1999} = -0.39$, $p = 0.12$ and $r_{2000} = -0.70$, $p < 0.01$).

Figure 6 shows the association between immunization coverage rates and total per capita physician and hospital costs for pneumonia ($r_{1999} = -0.57$ and $r_{2000} = -0.79$ with both $p < 0.05$).

Figure 7 shows the association between immunization coverage rates and per capita in-hospital mortality for pneumonia ($r_{1999} = -0.30$, $p = 0.24$ and $r_{2000} = -0.57$, $p < 0.05$).

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Table 1 – Yearly distribution of community-acquired pneumonia in Alberta health regions averaged for April 1, 1999 until March 31, 2001

Alberta Health Regions	Number of seniors (less than 65 years)	Number of cases of ambulatory community-acquired pneumonia	Number of cases of pneumonia requiring hospitalization	Average hospital costs per pneumonia case	In-hospital mortality rate per pneumonia hospitalization
Chinook	19,642	1,167	429	$4,406	12.37%
Palliser	11,844	708	250	$4,379	12.50%
Headwaters	7,644	576	203	$4,535	9.49%
Calgary	83,348	5,459	1,309	$4,891	14.61%
Health Authority 5	6,939	402	167	$3,979	9.66%
David Thompson	20,745	1,481	500	$4,094	10.50%
East Central	15,015	931	361	$3,900	10.23%
Westview	7,196	394	147	$4,634	8.16%
Crossroads	4,556	370	127	$4,365	11.89%
Capital	88,081	5,438	1,539	$5,381	16.54%
Aspen	8,679	649	224	$4,091	9.76%
Lakeland	12,629	962	349	$4,236	9.41%
Mistahia	7,257	458	191	$4,133	14.52%
Peace	1,921	161	90	$3,828	8.45%
Keeweetinok	1,406	147	90	$3,953	6.30%
Northern Lights	845	74	28	$4,029	5.57%
Northwestern	726	71	38	$4,172	7.74%
Alberta	**298,473**	**19,444**	**6,038**	**$4,651**	**12.93%**

Table 2 – Averaged costs and mortality for community and hospital diagnosed pneumonia in Alberta health regions between April 1, 1999 until March 31, 2001

Alberta Health Regions	Cost of all Physician Pneumonia Claims per Senior in the Population	Costs for Pneumonia Requiring Hospitalization per Senior in the Population	In-Hospital Mortality Rate for Pneumonia Requiring Hospitalization per 1,000 Seniors in the Population
Chinook	$7.5	$96.5	2.6
Palliser	$8.5	$93.0	2.6
Headwaters	$8.5	$120.0	2.5
Calgary	$7.5	$77.0	2.3
Health Authority 5	$8.0	$96.5	2.2
David Thompson	$9.5	$99.0	2.5
East Central	$8.0	$94.0	2.4
Westview	$7.5	$95.0	1.7
Crossroads	$12.0	$120.5	3.3
Capital	$8.5	$94.0	2.9
Aspen	$10.0	$101.0	2.4
Lakeland	$9.5	$119.5	2.6
Mistahia	$9.0	$110.5	3.8
Peace	$12.0	$165.0	3.8
Keeweetinok	$16.5	$251.0	3.9
Northern Lights	$12.5	$134.0	1.8
Northwestern	$13.5	$216.5	4.1
Alberta	**$8.5**	**$94.5**	**2.6**

Figure 1 – Average attack rate of ambulatory pneumonia

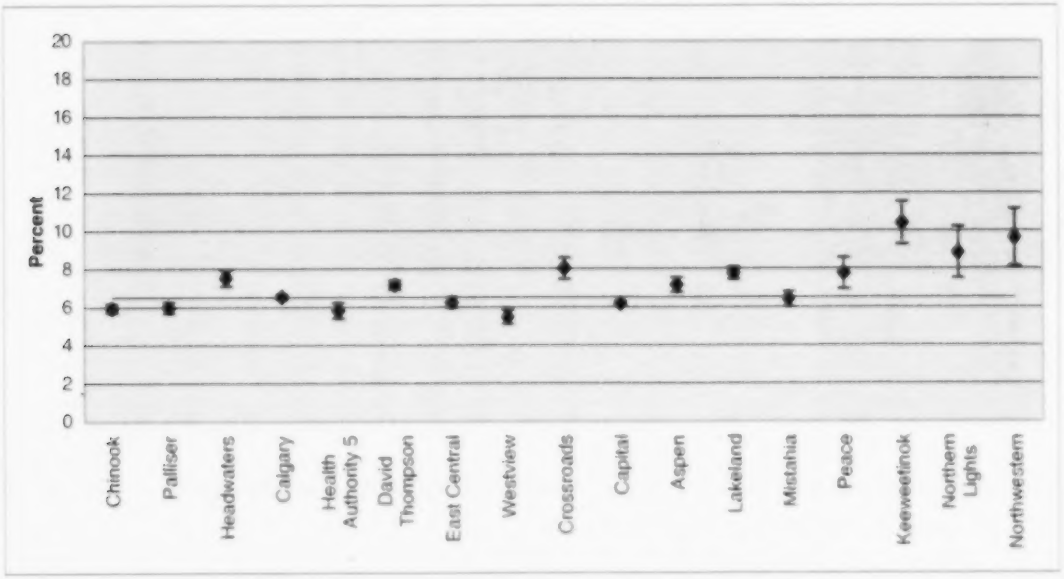


Figure 2 – Average annual immunization rate by health care region

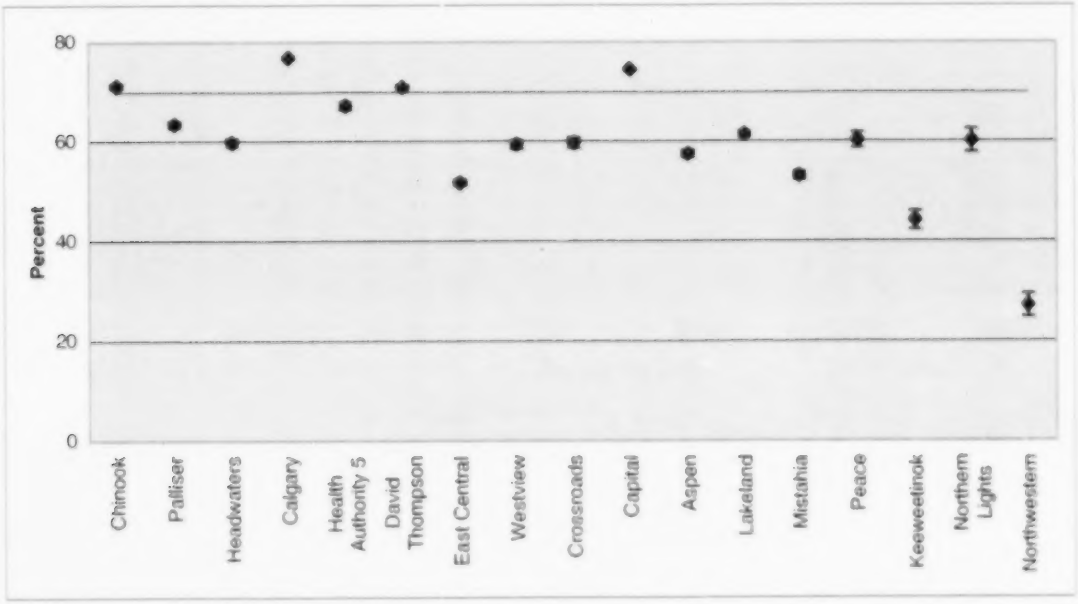


Figure 3 – Average attack rate of pneumonia requiring hospitalization

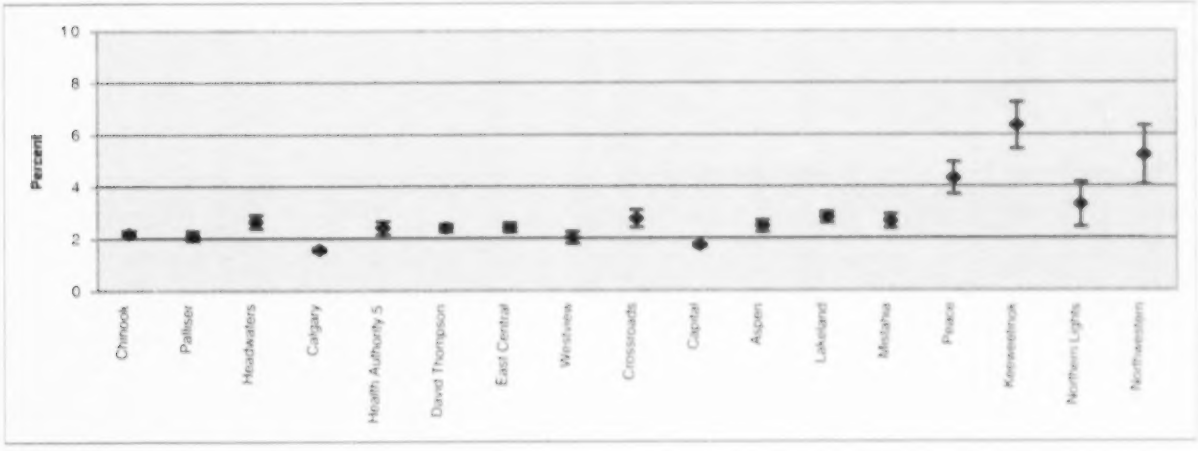


Figure 4 – Per capita cost for treating community-acquired pneumonia

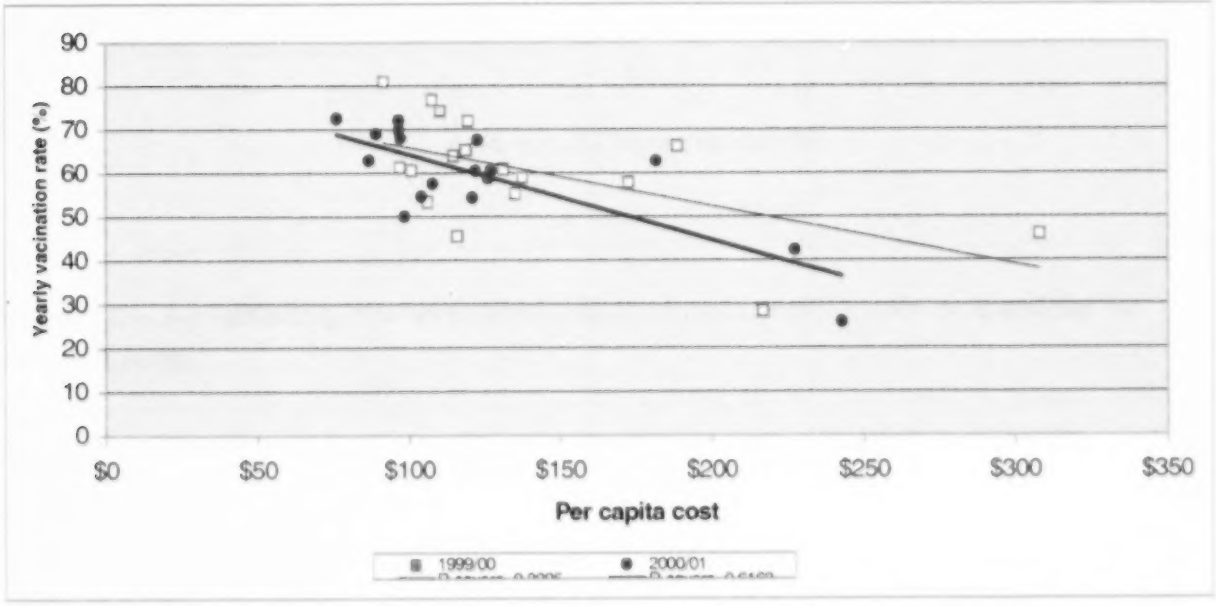


Figure 5 – Hospitalization rate for community-acquired pneumonia

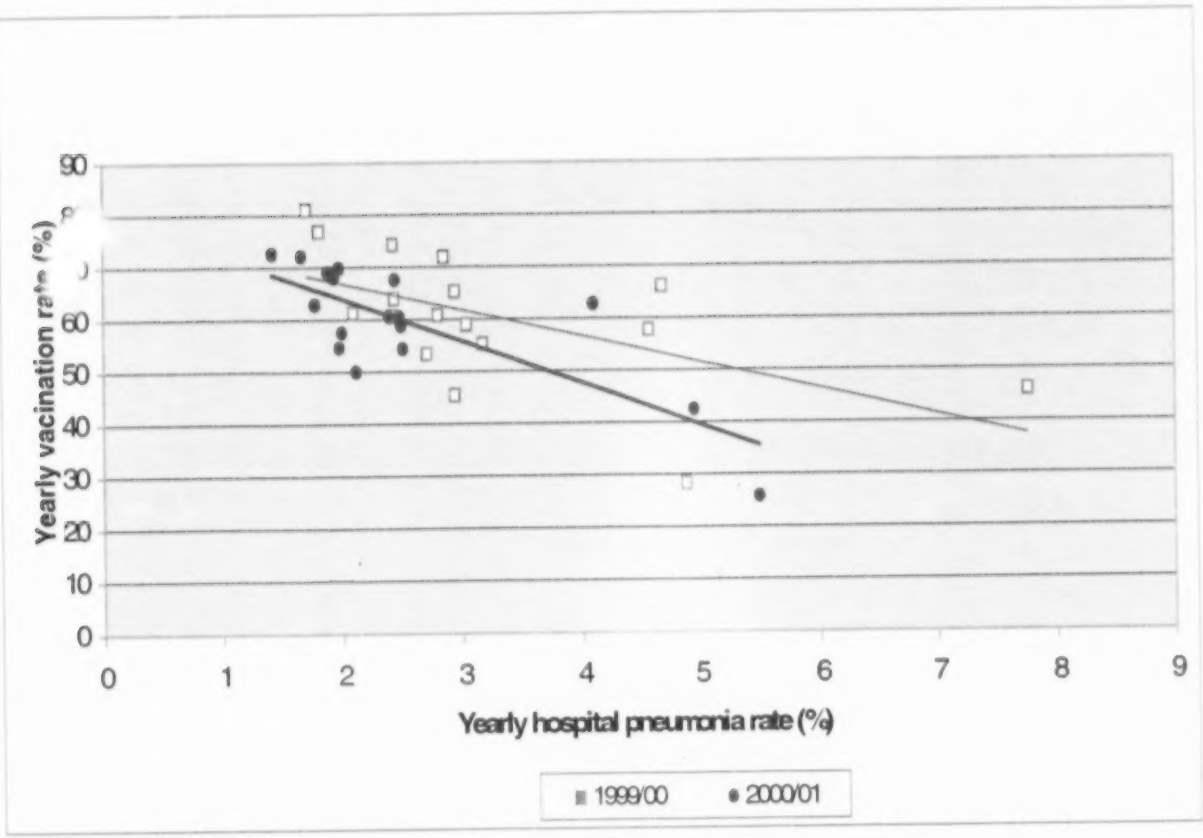


Figure 6 – Ambulatory community-acquired pneumonia rate according to the influenza

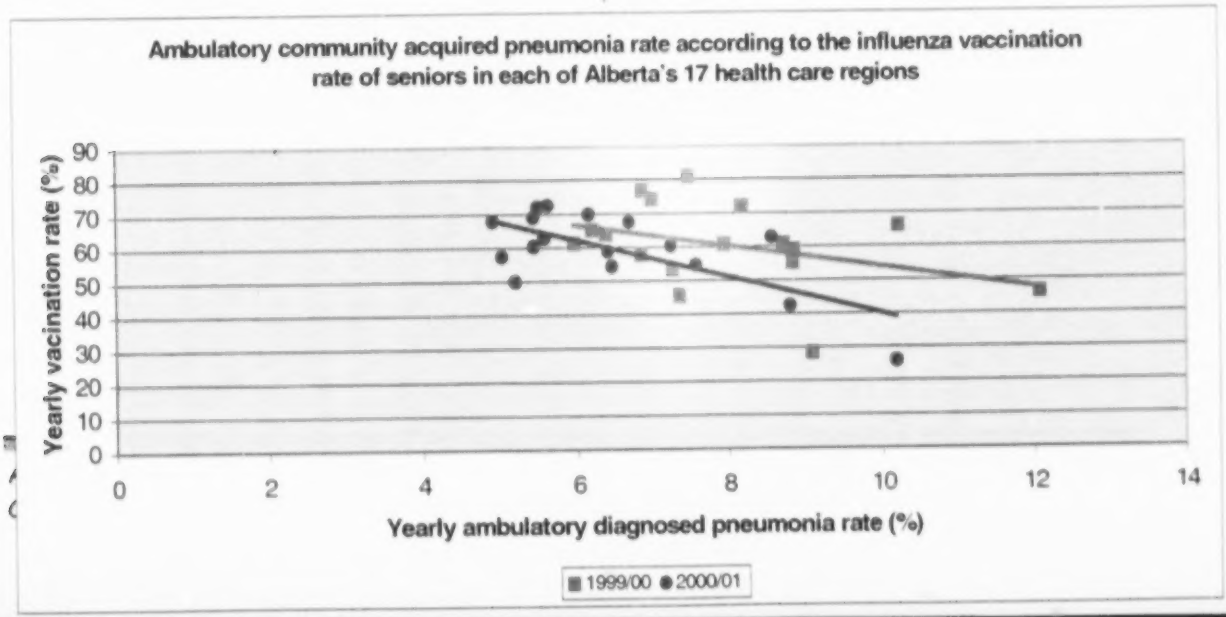
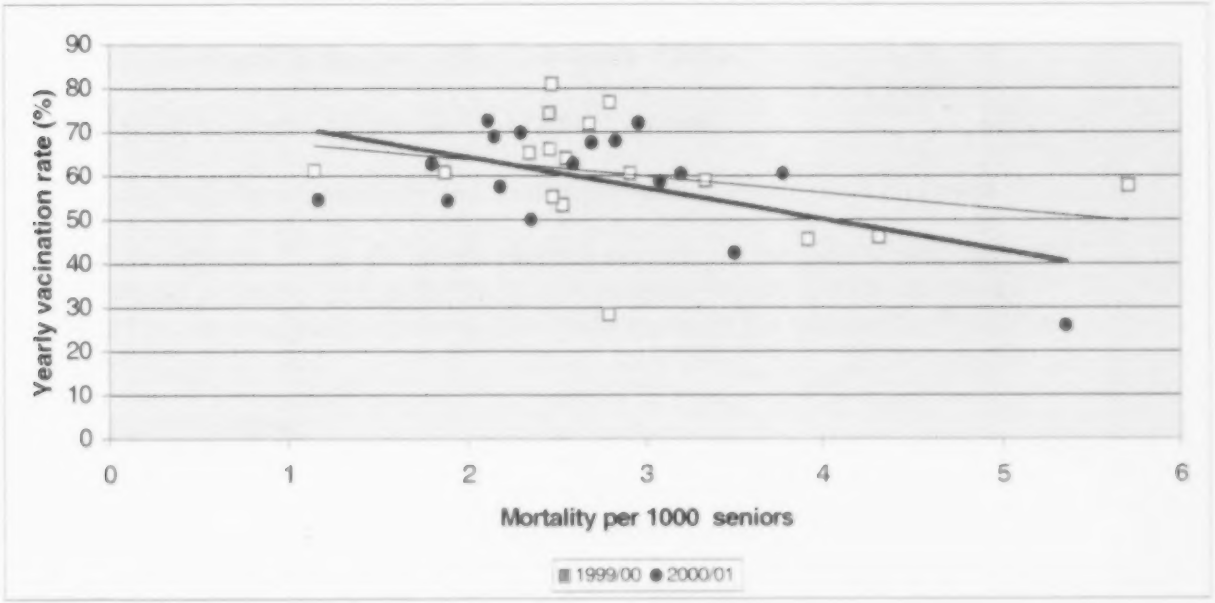


Figure 7 – In-hospital mortality rate for patients with community-acquired pneumonia according to the vaccination rate of seniors in each of Alberta's 17 health care regions



BIOGRAPHIES

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As a demographer, Yan Jin is interested in applying demographic and statistical techniques in health field, particularly in population health and health service utilization. He has taught demographic techniques at the University of Alberta.

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Dr. Carrière's areas of research include multivariate methods, design and analysis of repeated measures data, missing data, and multivariate Behrens-Fisher problems. Dr. Carrière's area of application is in health services research, where her contribution in this area led her to win the National Health Scholar Award (1996-2001) from the National Health Research and Development Program (NHRDP). She is a Senior Scholar with Alberta Heritage Foundation for Medical Research (AHFMR) (1999-2004) and is currently funded by the following organizations: NSERC, MRC, NHRDP, AHFMR, and NCIC.

Dr. Carrière is an elected board member of the Western North American Region of International Biometrics Society (2000-2002), a past member of its regional advisory board, and past elected executive member for the Section on Health Policy Statistics of the American Statistical Association (1999-2001). Dr. Carrière organized and chaired as well as invited and contributed paper sessions at major national and international conferences, including the recent Edmonton Statistics and Health conference in June, 2000.

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Major responsibilities include managing health protection programs and monitoring and reporting on the health status of the population. Annually, Dr. Predy produces a health status report entitled "How Healthy Are We?" which makes use of population health indicators and the influence of the determinants of health.

Leading an initiative to address three priority issues in population health including heart disease/stroke, injury control and addressing the health needs of an aging population. Two additional priorities of low birth weight and healthy weights have been added recently.

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Dr. Marrie's major research interest is in the area of community-acquired pneumonia. Over the years this focus has evolved from laboratory based research to a population health basis. Dr. Marrie's interest is in understanding the variation that occurs in the treatment of pneumonia and finding ways to minimize this variation.

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